Dalton (J. C.)

A NEW METHOD

OF

DETERMINING THE POSITION OF ABSORPTION BANDS

IN THE

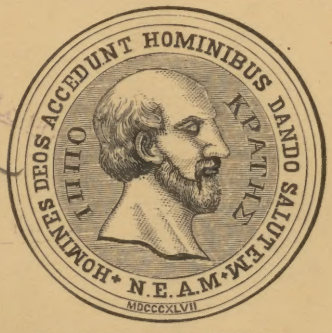
SPECTRUM OF COLORED ORGANIC FLUIDS.

BY

J. C. DALTON, M. D.,

PROFESSOR OF PHYSIOLOGY IN THE COLLEGE OF PHYSICIANS AND SURGEONS, NEW YORK; VICE-PRESIDENT OF THE NEW YORK ACADEMY OF MEDICINE.

[*FROM THE TRANSACTIONS OF THE NEW YORK ACADEMY OF MEDICINE FOR OCTOBER*, 1874.]



UNA FIDES, ALTARE COMMUNE.

NEW YORK:
D. APPLETON & COMPANY,
549 & 551 BROADWAY.
1874.

A NEW METHOD

OF

DETERMINING THE POSITION OF ABSORPTION BANDS

IN THE

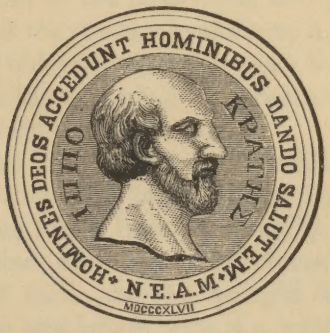
SPECTRUM OF COLORED ORGANIC FLUIDS.

BY

J. C. DALTON, M. D.,

PROFESSOR OF PHYSIOLOGY IN THE COLLEGE OF PHYSICIANS AND SURGEONS, NEW YORK; VICE-PRESIDENT OF THE NEW YORK ACADEMY OF MEDICINE.

[*FROM THE TRANSACTIONS OF THE NEW YORK ACADEMY OF MEDICINE FOR OCTOBER*, 1874.]



UNA FIDES, ALTARE COMMUNE.

NEW YORK:
D. APPLETON & COMPANY,
549 & 551 BROADWAY.
1874.

ON A NEW METHOD OF DETERMINING THE POSITION OF ABSORPTION BANDS IN THE SPECTRUM OF COLORED ORGANIC FLUIDS.

By J. C. DALTON, M. D.,
PROFESSOR OF PHYSIOLOGY IN THE COLLEGE OF PHYSICIANS AND SURGEONS, NEW YORK.

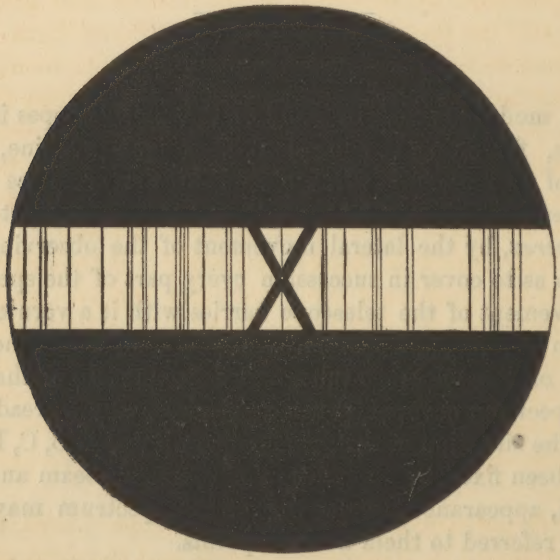
Read October 8, 1874.

The mode adopted, in many of the spectroscopes in common use, for fixing the location of a spectrum line, is by means of two crossed wires, placed in the eye-piece of the instrument, which may be made to traverse, from right to left or *vice versa*, by the lateral movement of the observing telescope, so as to cover in succession every part of the spectrum. The movement of the telescope carries with it a vernier, sliding upon a horizontal graduated circle, upon which the exact position of the telescope tube, and consequently of that part of the spectrum covered by the cross-wires, may be read off at will. The situation of the principal sun lines, A, B, C, D, etc., having been fixed by observation of the solar beam and duly recorded, appearances in any part of the spectrum may afterward be referred to them as fixed points.

This method is well adapted for astronomical or chemical purposes, in determining with precision the location of the dark sun lines or of the bright lines produced by incandescent vapors; since these lines are of excessive fineness and definition, and any one of them may be brought to correspond accurately, both above and below, with the reëntering angles of the crossed wires (Fig. 1). But it is not convenient for the observation of absorption bands. These bands are very different in character from the delicate, but sharp and mathematically delineated sun lines. An absorption band is simply

a dim space in the spectrum, the central parts of which may be completely black, owing to the total absorption of light, while the edges are almost invariably more or less shaded off, merging gradually into the adjacent illuminated regions. Thus there is no exact point at which we can say with absolute accuracy that an absorption band either begins or ends; and even the position of its centre is necessarily more or less a matter of estimate by the eye. Consequently, the extreme precision of measurement, which is attainable and useful in the

FIG. 1.



FIELD OF THE SPECTROSCOPE, SHOWING A PART OF THE SPECTRUM, WITH THE SUN LINES AND CROSSED WIRES.

case of the sun lines, is neither possible nor necessary for absorption bands; particularly as these bands vary in intensity and extent, and, according to some observers, even a very little in position, with the density of the solutions used for observation.

Beside this, the crossed wires make a coarse and disagreeable object in the field of the spectroscope, and often cover a considerable part of the absorption band which we desire to

examine. Owing to this difficulty, a fine vertical silver wire may be substituted for them with considerable advantage. This appears, in the bright parts of the spectrum, as a single dark line, drawn from above downward, and movable, like the crossed wires, with the changing position of the observing telescope. In the dark parts of the spectrum it may be illuminated by means of a lateral opening in the tube of the eye-piece and a small side mirror, so as to appear as a bright line easily visible by contrast.

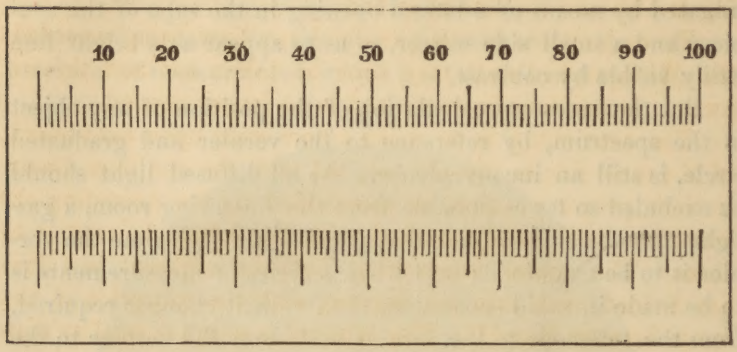
But the necessary calculation of the position of any object in the spectrum, by reference to the vernier and graduated circle, is still an inconvenience. As all diffused light should be excluded so far as possible from the observing room, a gas-light must be turned on and shut off again each time the vernier is to be examined; and when a series of measurements is to be made in rapid succession, the frequent changes required, from the telescope to the vernier and from the vernier to the telescope, are a real source of annoyance and delay. Add to this the calculation in figures necessary for translating the degrees of the graduated circle into the relative position of the sun lines, and it will be seen that the method in question is in no small degree circuitous and troublesome. For these reasons, I have been led to adopt another plan, in which, by a single direct observation, the position of an absorption band may be immediately and easily referred to that of the adjacent sun lines.

For this purpose, a third or scale telescope is used, similar to that employed in many astronomical and chemical spectroscopes, so arranged as to throw the illuminated image of a graduated scale upon the hither face of the prism, from which the spectrum emerges; so that, when both telescopes are properly focused, the spectrum and the scale will be visible together in the field of the spectroscope.

An arbitrary scale is first drawn, with fine black lines in Indian ink, upon smooth, white card-board, about twenty inches long by seven or eight inches wide, with every tenth degree properly numbered, up to 150 or 200, according to the

length of the spectrum in the instrument used by the observer; a blank space being left between the corresponding scale lines, above and below, which is to be occupied by the spectrum. The first half of such a scale, as drawn upon the card-board, is represented in Fig. 2.

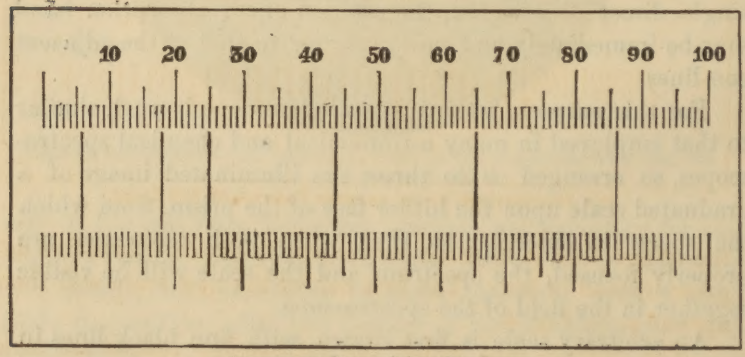
Fig. 2.



Arbitrary Scale on Card-board.

The above scale should then be photographed, in negative, upon a circular glass plate, to be inserted into the end of the scale telescope; the photographed scale to be of such a size

Fig. 3.



Arbitrary Scale, with Sun Lines.

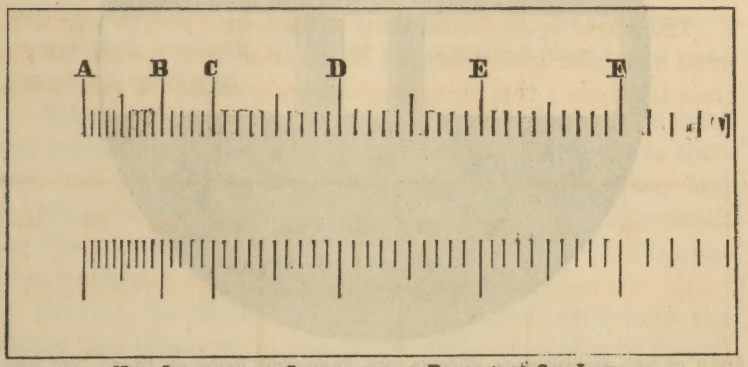
that, when seen in the field of the observing telescope, its image will fairly include the entire length of the spectrum.

With the scale thus fixed in position, a sunbeam is then admitted through the slit of the spectroscope, and the position of the principal sun lines, in respect to the degrees of the scale, accurately noted. Suppose, for example, that the line A comes at 6, B at 18, C at 25, D at 44, E at 65, and F at 86, as in Fig. 3; the line G, in the continuation of the scale, coming at 126, and the line H at 162.

These positions of the principal sun lines being recorded, the photographed scale may then be taken out and thrown away. It has done its work, and is no longer needed.

The next thing is to make a new scale upon card-board, of the same size as the old one, but with the sun lines drawn in their proper position, as ascertained by the preceding observation, and plainly marked with the letters belonging to them. The spaces intervening between adjacent sun lines are divided, each into ten degrees, with the exception of the space between B and C. This interval is so much smaller than

Fig. 4.



New Spectroscope Scale, showing Position of Sun Lines.

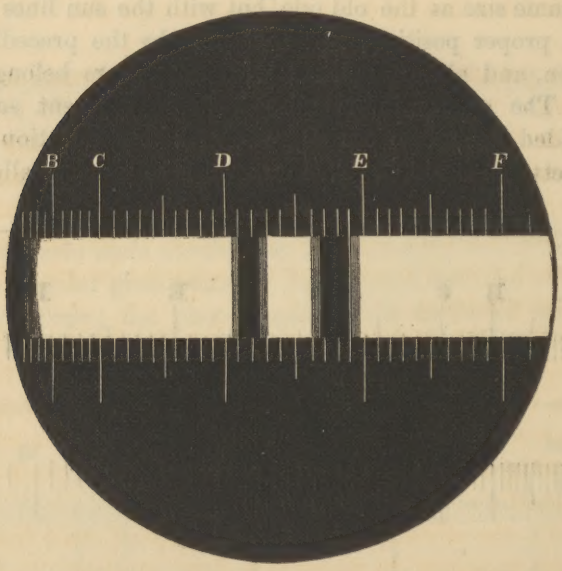
the others that it is more convenient to divide it into five degrees instead of ten. The first half of the new scale will then appear as in Fig. 4.

The degrees into which the intervening spaces are thus marked off will vary in size in different parts of the spectrum; the degrees between D and E, for example, being wider than those between A and B, and those between F and G wider

than those between D and E. But there is no disadvantage in this inequality, since the degrees, in any case, are only for the purpose of properly dividing the space between any two adjacent sun lines, and of enabling us to measure with accuracy one-half, one-quarter, or one-tenth of the distance from one of these lines to the other.

The second scale, when drawn upon card-board in the manner above described, is then photographed in negative upon a glass plate, to exactly the same size as was done with the first; and this second photographed scale is inserted and per-

Fig. 5.



Field of the Spectroscope, showing the Absorption Bands of Blood, and the Spectroscope Scale.

manently fixed in the extremity of the scale telescope. By observation of the sunbeam the accuracy of position of all the lettered lines is verified; and we then have a graduated scale, visible in the field of the spectroscope, by which the position of an absorption band, in any spectrum, by artificial light, may be determined at a glance, without reference to a graduated circle or any numerical calculation. In Fig. 5 is

shown the appearance of that part of the spectrum which contains the two absorption bands of aërated blood, with the corresponding portion of the scale; showing that the first band occupies a little more than the space between the first and the third degree from D to E, the second rather more than that between the sixth and the ninth.

If we express the distance between D and E in hundredths instead of tenths, we should say that the first absorption band of blood extended from 8 to 30 degrees of this distance, and the second band from 60 to 95. The photographed scale may be illuminated at pleasure, by a mirror, from the same burner which furnishes the light for the spectroscope slit.

Three precautions are necessary in using the scale arranged as above:

In the first place, the collimator tube, bearing the slit of the spectroscope, which is usually made movable, must be permanently fastened with screws, in such a way as never to vary its position with regard to the prism of the instrument; for any such variation will alter the apparent length and position of the spectrum.

Secondly, the scale telescope must also be secured from any accidental change of position. It may be made to traverse, in a horizontal plane, by means of a strong spring and thumb-screw; another thumb-screw being placed underneath for the purpose of fastening it, when the proper position has been reached.

Finally, the distance of the photographed scale from the lens of the telescope in which it is fixed must also be invariable. Changing this distance increases or diminishes the apparent length of the scale, as viewed in the observing telescope; and although this does not perceptibly alter the position of the more central lines, as E and F, it does make a difference with those near the extreme parts of the spectrum, as A, B, G, and H. The most convenient distance for use may be fixed at the time of observing the sun lines with the first arbitrary scale, and it should not be afterward changed.

The principal practical difficulty in perfecting the arrangement described above, has been that of obtaining a photographed scale on glass, with the lines sufficiently delicate and the intervening spaces sufficiently opaque; so that the dark background of the scale should not admit any light, to obscure or confuse the spectrum. I am much indebted to Mr. Mason, the photographer at Bellevue Hospital, for the ingenuity and perseverance by which, after many trials, he succeeded in accomplishing this result.

It need hardly be said that the two telescopes, bearing respectively the slit and the scale, should be carefully protected from any mechanical shock or pressure which might endanger the accuracy of their position. Every thing depends upon this position, once fixed, remaining unaltered; and on that account it is well to repeat occasionally the verification of the scale by observation of the sunbeam, or of the sodium line in a candle-flame, which, of course, should correspond exactly with the D line of the photographed scale.